REMARKS

In the office action, the Examiner rejected claims 1, 2, 4-9, 11-13, 15-17, 19, 22-25, and 28 pursuant to 35 U.S.C. §102(e) as being anticipated by Skyba, et al. (U.S. Patent No. 6,692,438). Claims 3, 18, 20, 21, 26, 27, and 29-31 were rejected pursuant to 35 U.S.C. §103(a) as being unpatentable over Skyba, et al. in view of Hossack, et al. (U.S. Patent No. 6,755,787). Claims 20, 21, 30 and 31 were rejected pursuant to 35 U.S.C. §103(a) as being unpatentable over Skyba, et al. in view of Sumanaweera, et al. (U.S. Patent No. 6,443,894). Claims 10, and 14 were rejected pursuant to 35 U.S.C. §103(a) as being unpatentable over Skyba, et al. in view of Chiang, et al. (U.S. Patent No. 6,969,352).

Applicants respectfully request reconsideration of the rejections of claims 1-31, including independent claims 1, 16, 17, and 28.

Independent claim 1 recites identifying a phase of a cyclically varying imaging parameter relative to a physiological cycle for each of a plurality of spatial locations in each of a plurality of image frames, the phase for at least one of the spatial locations in a first image frame different than the phase for another of the spatial locations in the first image frame, the cyclically varying imaging parameter having continuity of starting and end points in a parameter cycle, displaying a plurality of images corresponding to the plurality of image frames, each of the plurality of images associated with a different time within the physiological cycle and representing at least a two-dimensional region of a patient, and highlighting spatial locations in a first image of the plurality of images associated with a first phase and spatial locations in a second image of the plurality of images associated with a second phase, the second phase different than the first phase and the second image corresponding to the different time than the first image.

Skyba, et al. do not disclose identifying a phase of a cyclically varying imaging parameter relative to a physiological cycle for each of a plurality of spatial locations in each of a plurality of image frames, the phase for at least one of the spatial locations in a first image frame different than the phase for another of the spatial locations in the first image frame, and the cyclically varying imaging parameter having continuity of starting and end points in a parameter cycle. First, Skyba, et al. do not identify phases for respective spatial

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locations in each image. Skyba, et al. acquire images from different phases of the heart cycle (col., 4, line 65-col. 5, line 1). Different images are triggered based on the heart cycle (col. 5, lines 21-38) or may be acquired continuously (col. 5, line 21). Skyba, et al. identify the phase of the heart cycle associated with each image, such as image 1 being at the R wave and image 2 being at the Q wave (see Figure 5). Skyba, et al. provide one heart cycle phase for each image frame, so do not identify the phase for at least one of the spatial locations in a first image frame different than the phase for another of the spatial locations in the first image frame.

Once a group of images with a same phase is formed, the perfusion curve for each spatial location is determined (col. 6, lines 20-44). Since the images in the group all have a same phase relative to the heart cycle, motion of the heart is not a factor. Instead, the perfusion steady state (A) and rate of change (B) are determined for each spatial location. Skyba, et al. do not identify phases for respective spatial locations in each image.

Second, Skyba, et al. identify the phase based on the ECG, not a cyclically varying imaging parameter where the cyclically varying imaging parameter has continuity of starting and end points in a parameter cycle. ECG is an electrical input signal, not an imaging parameter. The Examiner alleges the perfusion/reperfusion vary over the course of a heart cycle, and would qualify as a cyclically varying imaging parameter (Advisory Action). The Examiner notes that cyclical variation does not infer continuity in start/end points of a cycle (Advisory Action). For example, perfusion increases to and holds at a steady state. Skyba, et al. show such exponential curve at 110 in Figure 12. The intensity is represented by the y-axis, and the x-axis is the frame number or heart cycle number. As shown, the curve 110 does not vary cyclically such that the cyclically varying imaging parameter has continuity of starting and end points in a parameter cycle.

Any perfusion, followed by reperfusion also does not provide a cyclically varying imaging parameter. Skyba, et al. provide for an initial high intensity or MI pulses to destroy any perfused contrast agent (col. 5, lines 7-13). Subsequently, low intensity or MI pulses are used for imaging (col. 5, lines 13-17). At most, this provides for initial perfusion, followed by destruction, and then perfusion for imaging and analysis. This provides a "U" or "V" shape curve of intensity as a function of heart cycle or frame. This pattern does not provide

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cyclical variation such that the cyclically varying imaging parameter has continuity of starting and end points in a parameter cycle.

Independent claim 16 recites identifying a phase of a cyclically varying imaging parameter relative to a heart cycle for each of a plurality of spatial locations in each of a plurality of image frames. Accordingly, claim 16 is allowable for the same reasons as claim 1.

Independent claim 17 recites matching a sinusoid waveform with the ultrasound data for each of the pluralities of spatial locations over the physiological cycle, the sinusoid waveform matched for one of the spatial locations at a first time different than the sinusoid waveform matched for another one of the spatial locations at the first time. Skyba, et al. match an exponential representing perfusion of contrast agents, not a sinusoid waveform.

The Examiner cites to synchronizing the ECG cycle as the sinusoid with ultrasound acquisition data (Advisory Action). However, the ECG has a single phase relative to a given time. The ECG data is used to trigger or mark each image. Each image is labeled as occurring at a particular time in the ECG heart cycle. Skyba, et al. do not match such that the sinusoid waveform matched for one of the spatial locations at a first time is different than the sinusoid waveform matched for another one of the spatial locations at the first time.

Claim 17 also recites isolating information associated with at least one frequency band from information associated with a different frequency band for each of the plurality of spatial locations as a function of the matched sinusoid for the respective spatial location. The Examiner cites to col. 3, lines 10-65 of Skyba, et al. A desired transmit frequency band is used (col. 3, lines 20-25 and 38-42). The transmit activation may be synchronized with the heart cycle waveform provided by the ECG device (col. 3, lines 25-33). For receiving echoes, a filter filters the received signals (col. 3, lines 54-65). The filtering is to isolate information at a desired band, such as at the transmit band or a harmonic band. Skyba, et al. transmit at one band (e.g., 2 MHz center frequency), and receive the echo signals. The received signals are filtered at the same or different band (e.g., 2 or 4 MHz center frequency) to remove noise or other undesired information. The same filtering is performed for each

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spatial location. Skyba, et al. do not isolation information for each of the spatial locations as a function of the respective matched sinusoids for each respective spatial location.

Independent claim 28 recites matching a sinusoid waveform with the ultrasound data for each of the pluralities of spatial locations, and isolating information associated at least one frequency band from information associated with a different frequency band for each of the plurality of spatial locations as a function of the matched sinusoid. As discussed above for claim 17, Skyba, et al do not disclose these limitations.

Dependent claims 2-15, 18-27, and 29-31 depend from the independent claims so are allowable for the same reasons as the corresponding base claim. Further limitations patentably distinguish from the cited references.

Claim 2 recites matching a sinusoid, and identifying a phase of the sinusoid relative to the time within the physiological cycle. Skyba, et al. use ECG information to select images for a heart cycle phase. The images are then used to match an exponential curve to the data. Skyba, et al. do not match a sinusoid, and do not identify a phase of the sinusoid relative to the time within the physiological cycle.

Claim 4 recites identifying the phase for single pixels. Skyba, et al. use heart cycle phase for images, not single pixels. Skyba, et al. match the exponential using nine pixels for each image (col. 6, lines 21-24), not single pixels. As noted by the Examiner, Skyba, et al. determine mean pixel values over time for a given phase of the heart cycle. However, the phase is based on the entire image, so is not identified for single pixels. Averaging phase data does not provide a phase for single pixels.

Claim 6 recites highlighting by setting the imaging parameter to a darker shade for spatial locations associated with the different phases. Skyba, et al. create a parameter image, but does not suggest darker regions for spatial locations associated with a particular phase. The Examiner cites to col. 7, lines 12-37. Skyba, et al. mention "light up" of the tumor. This light up is common for contrast agent imaging, where contrast agents have a stronger return than tissue. Perfused tissue appears brighter. However, this lighting up is independent of the

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phase and is not setting the cyclically varying imaging parameter to a darker shade, but instead showing contrast agent as brighter regardless of phase.

Claim 11 recites highlighting of one image associated with a first phase and free of highlighting for the second phase. Skyba, et al. generate a parameter image for each phase of the heart cycle. The parameter is used to create the image. Skyba, et al. do not disclose highlighting an already existing image. Each parametric image of Skyba, et al. is associated with a different phase. However, highlighting is not provided in any of the images. Instead, the perfusion curve provides the display values for each pixel without highlighting data at one phase relative to another phase.

Claim 23 recites generating images of intensities as a function of time responsive to adding information from a different frequency band to isolated information. Skyba, et al. generate images of intensities as a function of time to represent perfusion. The images are not generated responsive to adding information from a different frequency band to isolated information. Skyba, et al. provide received signals at a frequency band. There is no teaching to add information from different bands and generate an image.

Claim 25 recites addition in the frequency domain. Skyba, et al. do not show the addition, and does not show any functions in the frequency domain. Skyba, et al. show time domain digital filtering, not performing operations in the frequency domain.

Claims 3, 18, 20, 21, 26, 27, and 29-31 are allowable since a person of ordinary skill in the art would not have used the Fourier transform in Skyba, et al., especially as taught by Hossack, et al. Skyba, et al. use ECG signals to label the heart cycle phase associated with each image. There is no cyclical or frequency processing. Filtering is performed using transmit and receive techniques or FIR filtering. There is nothing in Skyba, et al. to suggest frequency domain processing and the corresponding use of a Fourier transform. Hossack, et al. teach Fourier transform for data compression. Data compression is unrelated to the teachings of Skyba, et al.

The Examiner notes that Fourier analysis is well known for shifting phase data and isolating phase angles. However, a person of ordinary skill in the art would not have used frequency domain techniques in the teachings of Skyba, et al. in the claimed manner. Skyba,

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et al. seek to remove heart cycle variation concerns by selecting images to process associated with a same phase based on ECG triggering. A person of ordinary skill in the art would not have used Fourier analysis to identify phases relative to a heart cycle since Skyba, et al. avoid collecting such information.

Claims 3 and 18 recite matching a sinusoid by performing a Fourier transform. Hossack, et al. use the transform for compression, not matching a sinusoid.

Claim 20 recites isolating information associated with an unvarying component and a fundamental frequency component by reducing values for information associated with second harmonics. This isolation is a function of the matched sinusoid. Skyba, et al. use pulse inversion to identify received signals with a harmonic response. This does not provide for isolating as a function of a matched sinusoid.

Claim 21 is allowable for a similar reason as claim 20.

Claims 27 and 29 recite transforming, isolating and inverse transforming the isolated information. Hossack, et al. teaches transforming an image while avoiding loss. Compression uses the relationship between pixels. There is no suggestion to transform data for a spatial location, and isolating frequency information associated with the spatial location.

Claim 31 recites detecting a boundary from phase data. Skyba, et al. detect a boundary from image data, not phase data. Sumanaweera, et al. use Doppler data, gradient data, marching cubes, tetrahedral tessellation, and tracing, but do not disclose using phase data. Harmonic data is data responding to a transmit acoustic beam at a harmonic frequency. Harmonic data is not phase data.

Claim 10 recites displaying and highlighting images where highlighting is of movement of a mechanical heart wave contraction wave. Chiang, et al. merely note use of an imaging device for pacemaker monitoring or cardiac rhythm management. There is no suggestion in Chiang, et al. or Skyba, et al. to highlight an image for movement of a mechanical heart wave contraction. The Examiner interprets this limitation to be highlighting for a mechanical heart. A mechanical heart wave contraction is a known

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concept associated with actual hearts. Chiang, et al. and Skyba, et al. do not suggest the limitations of claim 10.
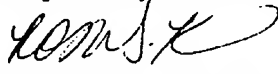
CONCLUSION

Applicants respectfully submit that all of the pending claims are in condition for allowance and seeks early allowance thereof. If for any reason, the Examiner is unable to allow the application but believes that an interview would be helpful to resolve any issues, he is respectfully requested to call the Craig Summerfield at (312) 321-4726.

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